

CLAIMS

1. A PET scanner comprising:

5 a scintillator block;

a plurality of photodetectors;

an optical element disposed between the scintillator block and the plurality of photodetectors, the optical element having:

10 a first layer that includes a central region having an outer wall and a peripheral region having an inner wall, the inner and outer wall being separated by a first gap; and

15 a second layer in optical communication with the first layer, the second layer including at least a first region and a second region, the first region having a first interior wall and the second region having a second interior wall opposite the first interior wall, the first and second interior walls being separated by a second gap.

20 2. The PET scanner of claim 1, wherein the first layer comprises a perimeter wall, and the peripheral region is adjacent to at least a portion of the perimeter wall.

3. The PET scanner of claim 1, wherein the peripheral region is adjacent to the entire perimeter wall.

25 4. The PET scanner of claim 1, further comprising one or more additional peripheral regions, the one or more additional peripheral regions being adjacent to a portion of the perimeter wall that is not adjacent to the peripheral region.

5. The PET scanner of claim 4, wherein an additional peripheral region is separated from the peripheral region by a gap.
6. The PET scanner of claim 5, wherein the gap extends to the perimeter wall.
- 5 7. The PET scanner of claim 1, wherein the inner wall and the outer wall have different optical characteristics.
8. The PET scanner of claim 7, wherein one of the inner wall and the outer wall is polished and the other is unpolished.
9. The PET scanner of claim 7, wherein one of the inner wall and the outer
10 wall is opaque and the other is not opaque.
10. The PET scanner of claim 7, wherein one of the inner wall and the outer wall is black and the other is not black.
11. The PET scanner of claim 7, wherein one of the inner wall and the outer wall is transparent and the other is not transparent.
- 15 12. The PET scanner of claim 7, wherein one of the inner wall and the outer wall is translucent and the other is not translucent.
13. The PET scanner of claim 7, wherein one of the inner wall and the outer wall is absorbtive and the other is not absorbtive.
14. The PET scanner of claim 7, wherein one of the inner wall and the outer
20 wall is configured to cause a specular reflection and the other is cause a reflection other than a specular reflection.
15. The PET scanner of claim 14, wherein the one of the inner wall and the outer wall that is configured to cause a specular reflection comprises a metal coating.

16. The PET scanner of claim 14, wherein the one of the inner wall and the outer wall that is configured to cause a specular reflection comprises a reflective coating.
- 5 17. The PET scanner of claim 14, wherein the one of the inner wall and the outer wall that is configured to cause a specular reflection has an index of refraction selected to cause total internal reflection of light incident thereon.
- 10 18. The PET scanner of claim 7, wherein one of the inner wall and the outer wall is configured to cause a diffuse reflection and the other is cause a reflection other than a diffuse reflection.
19. The PET scanner of claim 18, wherein the one of the inner wall and the outer wall that is configured to cause a diffuse reflection comprises a plastic coating.
- 15 20. The PET scanner of claim 18, wherein the one of the inner wall and the outer wall that is configured to cause a diffuse reflection comprises a coating of paint.
21. The PET scanner of claim 18, wherein the one of the inner wall and the outer wall that is configured to cause a diffuse reflection has a roughened surface.
- 20 22. The PET scanner of claim 7, wherein a surface of the inner wall is polished.
23. The PET scanner of claim 7, wherein an inner surface of the outer wall is roughened.
- 25 24. The PET scanner of claim 1, wherein the optical element further comprises a third layer disposed adjacent to the scintillator block.

25. The PET scanner of claim 1, wherein the first gap has an optical property that is different from a corresponding optical property of the central region and the peripheral region.
26. The PET scanner of claim 25, wherein the first gap comprises an air gap.
- 5 27. The PET scanner of claim 1, wherein one of the first interior wall and the second interior wall is polished and the other is unpolished.
28. The PET scanner of claim 1, wherein one of the first interior wall and the second interior wall is opaque and the other is not opaque.
- 10 29. The PET scanner of claim 1, wherein one of the first interior wall and the second interior wall is black and the other is not black.
30. The PET scanner of claim 1, wherein the first interior wall and the second interior wall are specularly reflecting walls.
31. The PET scanner of claim 1, wherein the second gap defines a grid of regions.
- 15 32. The PET scanner of claim 31, wherein the second gap extends across the second layer.
33. The PET scanner of claim 31, wherein the second gap extends part way across the second layer.
- 20 34. The PET scanner of claim 1, wherein the opposed first and second interior walls are parallel.
35. The PET scanner of claim 1, wherein the opposed first and second interior walls are not parallel.
- 25 36. The PET scanner of claim 31, wherein each region in the grid of regions is positioned to correspond to a photodetector from the plurality of photodetectors.

37. The PET scanner of claim 1, wherein the second gap is a cruciform gap.
38. The PET scanner of claim 37, wherein the cruciform gap comprises intersecting first and second arms, at least one of the first and second arms extending across the second layer.
- 5 39. The PET scanner of claim 37, wherein the cruciform gap comprises intersecting first and second arms, the first and second arms extending part way across the second layer.
40. The PET scanner of claim 1, further comprising a mask disposed to prevent scintillation photons emerging from selected portions of the optical element from reaching the photodetectors.
- 10 41. The PET scanner of claim 40, wherein the mask comprises regions forming apertures at locations opposite the photodetectors.
42. The PET scanner of claim 40, wherein the mask is disposed between the optical element and the photodetectors.
- 15 43. The PET scanner of claim 40, wherein the mask is absorbtive.
44. The PET scanner of claim 40, wherein the mask is reflective.
45. The PET scanner of claim 44, wherein the mask is specularly reflective.
46. The PET scanner of claim 44, wherein the mask is diffusely reflective.
47. An optical element for directing light from a scintillator block to a plurality of photodetectors, the optical element comprising:
- 20 a first layer in optical communication with the scintillator block, the first layer having a central region having an outer wall and a peripheral region having an inner wall, the inner and outer wall being separated by a first gap; and

a second layer in optical communication with the plurality of photodetectors and with the first layer, the second layer including at least a first region and a second region, the first region having a first interior wall and the second region having a second interior wall opposite the first interior wall, the first and second interior walls being separated by a second gap.

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48. The optical element of claim **47**, wherein the inner wall and the outer wall are configured such that a photon incident on the inner wall from the peripheral region encounters a first reflection coefficient that is greater than a second reflection coefficient encountered by a photon incident on the outer wall from the central region.

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49. The optical element of claim **47**, wherein an inner surface of the inner wall of the peripheral region has a greater reflection coefficient than an inner surface of the outer wall of the central region.

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50. The optical element of claim **49**, wherein the inner surface of the inner wall is polished.

51. The optical element of claim **49**, wherein the inner surface of the outer wall is roughened.

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52. The optical element of claim **47**, wherein the optical element further comprises a third layer disposed facing the scintillator block.

53. The optical element of claim **47**, wherein the first gap comprises an air gap.

54. The optical element of claim **47**, wherein the first interior wall and the second interior wall are specularly reflecting walls.

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55. The optical element of claim **47**, wherein the second gap defines a grid of regions.

56. The optical element of claim **55**, wherein each region in the grid of regions is positioned to correspond to a photodetector from the plurality of photodetectors.

5 57. The optical element of claim **47**, wherein the second gap is a cruciform gap.

58. A PET scanner comprising:

a scintillator block for generating a spatial light distribution of scintillation photons in response to illumination by a gamma ray photon;

10 means for an outer and inner the spatial light distribution of scintillation photons to generate a modified spatial light distribution; and

a plurality of photodetectors for receiving the modified spatial light distribution from the outer and inner means.

15 59. An optical element for directing light from a scintillator block to a plurality of photodetectors, the optical element comprising:

a structured outer layer in optical communication with the scintillator block; and

20 a structured inner layer in optical communication with the plurality of photodetectors.

60. A PET scanner comprising:

a scintillator block;

a plurality of photodetectors;

an optical element as recited in claim **59**, the optical element being disposed between the scintillator block and the plurality of photodetectors.